The Position of *Anomalurus* as indicated by its Myology.

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For several years I have been anxious to dissect the muscular system of *Anomalurus*, and to compare it with that of other rodents; I am therefore especially grateful to Professor Howes for kindly placing at my disposal a young specimen which originally came from the Congo. Personally I hold that muscles, if judiciously used, are capable of giving a great deal of information about the relationship of animals, because they do not readily adapt themselves to changed conditions of life. This opinion is the result of a systematic survey of the muscles of several orders of mammals, a survey which has occupied me for several years; and although, in the opinion of many anatomists, muscles are very unstable structures, I would submit that both in Dobson's hands, and to a lesser degree in my own, a certain amount of definite assistance has been afforded systematists by them in classifying animals whose position had previously been doubtful.

Anomalurus gives a very good opportunity for testing the resources of myology, since its position is so uncertain. A study of Oldfield Thomas's paper "On the Genera of Rodents"* will show how many different positions have been assigned this animal, and one can therefore enter upon the task of finding out what its muscles have to tell with a perfectly free and unbiassed mind.

It may be asked why I have elected to prefer the muscles to any of the other systems of the body as an index of relationship. It is chiefly a matter of convenience for comparison. The nervous, vascular, or alimentary systems may well have many secrets to tell, but in order to understand them it is necessary that the details of these parts in a large and representative series of other rodents should be recorded and collated. This work I have already done for the muscles†, and I am therefore able to describe these structures in *Anomalurus* more briefly than I should otherwise feel justified in doing, premising that those muscles which are not mentioned are fairly stable in all rodents and, in my opinion, of little or no value for classificatory purposes.

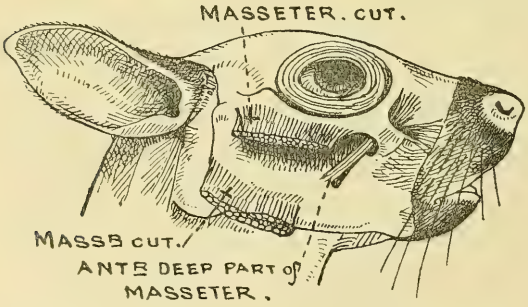
* P. Z. S. 1896, pp. 1012-1028. † P. Z. S. 1894, p. 251, & 1896, p. 159.

Muscles of the Head and Neck.

Temporal.—This muscle is quite small, as is usual in rodents. The three parts described by Kunstler *—parietal, temporal, and zygomatic—are present, but not very clearly defined. The muscles of opposite sides do not nearly meet in the mid-line; but it must be remembered that the specimen is that of a very young animal, and there is reason to believe that, with the growth of the teeth, the masticatory muscles become more developed and the temporal occupies more of the side of the cranium.

Masseter.—This is a muscle of great interest. In previous papers † I have pointed out that the hystricomorphine and sciuromorphine types of masseter are quite distinct, and it is well known that this difference causes a complete alteration in the shape of the skull. In most squirrel-like rodents no part of the masseter passes through the infraorbital foramen, but a special bundle, which has been spoken of as the sciuromorphine anterior deep part, occupies a nearly vertical groove in front of the zygomatic process of the maxilla. In the porcupine-like rodents a considerable part of the masseter, called the hystricomorphine anterior deep portion, passes through the

Fig. 1.



The Masseter of *Anomalurus*.

greatly enlarged infraorbital foramen; while the mouse-like rodents show the transition between these two arrangements, and often, as in the case of the Hamster (*Cricetus frumen-*

* Annales des Sciences Naturelles, sér. 7, t. iv. p. 150.

† P. Z. S. 1894, p. 251, and 1896, p. 159.

tarius)*, both the sciuromorphine and hystricomorphine anterior deep parts of the muscle are found in the same individual.

Anomalurus differs from all the sciuromorphine rodents I have hitherto examined in having a small anterior deep portion of the masseter passing through the infraorbital foramen, as in many of the Myomorpha, and this arrangement I cannot help regarding as a myomorphine tendency on the part of the animal.

Depressor mandibulæ (Digastric).—The great difference between the Sciuromorpha and Myomorpha on the one hand, and the Hystricomorpha on the other, is that in the former suborders this muscle is really digastric, and the tendons of opposite sides are connected across the middle line by a fibrous arcade with its convexity forward; from this convexity the anterior bellies spring in such a manner that the mesial borders of the two are in contact in the middle line, and the anterior attachments of these anterior bellies are close to the symphysis menti†. In the Hystricomorpha, on the other hand, the muscle does not deserve the name of digastric—the division between the anterior and posterior bellies is only indicated by a few tendinous fibres on its surface, there is no tendinous arcade, and the anterior attachment is some distance from the symphysis‡. *Anomalurus* agrees entirely with the first-mentioned arrangement.

Transversus mandibulæ.—This muscle connects the two halves of the mandible, just behind the symphysis, lying deep to the depressor mandibulæ and superficial to the mylohyoid; it is present in all the Myomorpha and Sciuromorpha except *Castor*. In *Anomalurus* it is well developed.

Sterno-cleido Mastoid.—The sterno-mastoid and cleido-occipital elements of this compound muscle are present in *Anomalurus*, the former running from the presternum to the base of the paroccipital process, the latter from the inner half of the clavicle to the curved line of the occipital bone; as is always the case in rodents, the spinal accessory nerve passes deep to both parts. In many rodents the cleido-occipital portion is often overlapped by the clavicular fibres of the trapezius, but this arrangement is not confined to any one suborder, and it does not exist in *Anomalurus*; but I do not at present regard the sterno-cleido mastoid as of much value from a classificatory point of view.

* See figs. 2 & 3, P. Z. S. 1896, pp. 161, 162.

† See fig. 1, P. Z. S. 1894, p. 255.

‡ See fig. 9, Journ. of Anat. & Physiol. vol. xxxii. p. 439.

Omo-hyoid.—This muscle I have hitherto found in every specimen of sciuromorphine and myomorphine rodent which I have dissected, but it is absent in many of the Hystricomorpha and in the Lagomorpha. In *Anomalurus* it is absent, and, if this should prove constant, it will be a mark of distinction between that animal and other sciuromorphine rodents.

The *Omo-trachelian* (*Levator claviculæ*) rises from the anterior arch and transverse process of the atlas and is inserted into the acromion and metacromion; these are its usual attachments in Sciuromorpha and Myomorpha, though in the Hystricomorpha and Lagomorpha it often rises from the basioccipital.

Rhomboidei.—The rhomboideus capitis in *Anomalurus* forms a continuous sheet with the cervical and thoracic parts of the muscle: this is generally the case in the Sciuromorpha, but in the Myomorpha the rhomboideus capitis is usually a distinct muscle.

Splenii.—The splenius capitis is always well developed in rodents, and in *Anomalurus* it has the usual arrangement; the splenius colli, on the other hand, is a rare muscle, and *Anomalurus* differs from most other rodents in having it well marked.

Trachelo-mastoid is present as in most rodents.

Scaleni.—A scalene muscle passing ventral to the subclavian artery and brachial plexus is never found in the Sciuromorpha, very rarely in the Myomorpha, but often in the Hystricomorpha and Lagomorpha. *Anomalurus* has no scalenus ventralis or anticus, as this muscle is usually called; it has, however, a scalenus longus passing to the anterior four ribs and, dorsad to that, a scalenus brevis inserted into the first rib.

Muscles of the Anterior Extremity.

The Pectoral Muscles.—I propose to adopt the same method of dividing this group that I have found to work fairly well in other rodents *. (α) The superficial manubrial fibres: these also rise slightly from the clavicle and pass superficially to all the other fibres to be inserted lowest of all, opposite the lower part of the insertion of the deltoid. (β) The greater portion of the muscle rises from the whole length of the manubrium and gladiolus and passes, deep to the last, to be inserted into the pectoral ridge. (γ) The abdominal fibres, or Pectoralis quartus, rise from the linea alba as far back as the umbilicus and are inserted into

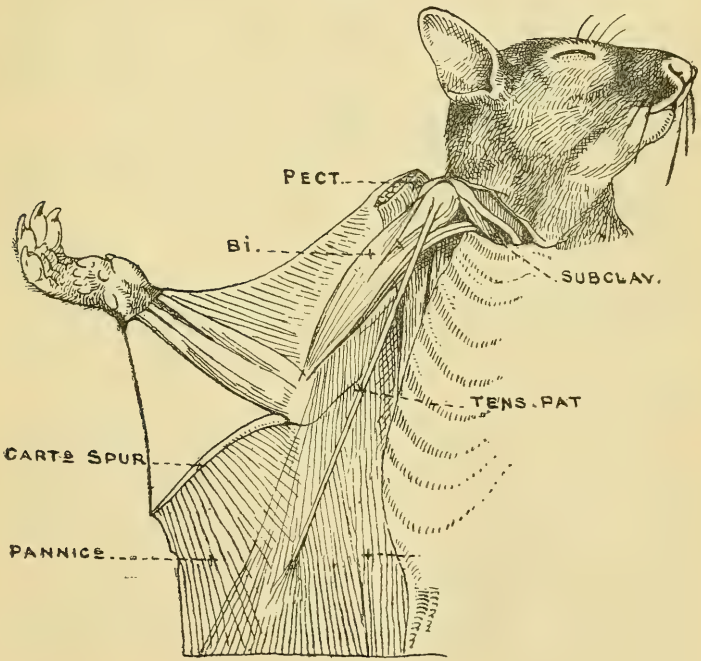
* P. Z. S. 1894, p. 259.

the neck of the humerus. (*c*) The deep portion, or Pectoralis minor, rises from the 3rd, 4th, and 5th costal cartilages at their junction with the sternum, and is inserted into the head of the humerus and capsule of the shoulder.

Subclavius.—This muscle is well developed, and is inserted into the posterior border of the outer third of the clavicle. This is the arrangement which is always present in sciuromorphine rodents. In the Hystricomorpha the subclavius is continued on to the spine of the scapula, covering the supraspinatus, and the whole muscle is called the sterno-scapularis. In the Myomorpha the arrangement is usually as in the Sciuromorpha.

The *Deltoid*, *Teretes*, *Supraspinatus*, *Infraspinatus*, and *Subscapularis* have the typical sciuromorphine arrangement and resemble the same muscles in *Sciurus*.

Fig. 2.



Muscles of Patagium and Arm.
Pect., Pectoralis; Bi., Biceps; Subclav., Subclavius; Tens. Pat., Coracopatagialis.

Flexor Longus Cubiti (Biceps).—This muscle has both heads well developed, it is inserted into the radius.

Flexor Brevis Cubiti (Coraco-brachialis).—The frequency with which all three parts of this muscle are present seems to be one of the characteristics of sciuromorphine rodents, and *Anomalurus* is no exception to this rule. The three parts are closely blended near their origin, and the upper part or rotator humeri is separated from the middle, as is usual, by the musculo-cutaneous nerve. The middle and lower portions (medius and longus) are closely united in their whole extent and are inserted from the upper third of the humerus as far as the internal condyle.

Coraco-patagialis.—A muscle with a small short fusiform belly and a long delicate tendon rises from the coracoid process, and is inserted into the patagium midway between the spur from the elbow and the trunk. Its action seems to be to act as a stay to the membrane, and keep its edge down during flight, thus rendering the part of the patagium between the arm and the body more concave and parachute-like. As I have never seen anything homologous with this muscle in other mammals, I have suggested the name "coraco-patagialis" for it.

Brachialis anticus.—This muscle resembles that of most sciuromorphine rodents in having the inner and outer heads so closely connected as to be inseparable.

The *Extensor Cubiti* (Triceps), *Anconeus*, and *Epitrochleo-anconeus* call for no special remark.

Latissimo-olecranalis (Dorso-epitrochlearis).—This rises from the tendon of the latissimus dorsi as well as from that of the teres major. It is inserted into the inner side of the olecranon process.

Serratus ventralis (Serratus magnus and Levator anguli scapulæ).—This continuous sheet rises from the transverse processes of the posterior five cervical vertebræ and from the anterior ten ribs; it is inserted as usual into the vertebral border of the scapula. I only know two other rodents, *Georychus* and *Bathyergus*, in which the rib origin is so extensive.

The *Pronator Radii Teres* is inserted below the middle of the radius; it rises, as in *Sciurus* and *Pteromys*, from the lower part of the arch over the supracondylar foramen.

The *Flexor Carpi Radialis* and *Palmaris Longus* have the usual human attachments and relations.

The *Flexor Sublimis Digitorum* divides into three tendons for the index, medius, and annularis. There is no slip for the minimus; and I have called attention to this arrangement * as constantly occurring in the Myomorpha.

In the *Flexor Carpi Ulnaris* both olecranal and condylar heads are present, they join high up, and the usual insertion into the pisiform bone occurs.

The *Flexor Profundus Digitorum* has the five parts of the typical muscle—1, radial; 2, ulnar; 3, radio-condylar; 4, ulno-condylar; 5, centro-condylar. The latter joins the rest of the muscle about the wrist-joint.

The *Lumbricales* are peculiar; there were six in each hand in my specimen. One rose from each side of the two middle tendons, one from the ulnar side of the tendon to the index, and one from the radial side of the minimus tendon. They were too small for the nerve-supply to be made out with certainty.

The *Pronator Quadratus* is only attached to the lower quarter of the forearm. The Sciuromorpha are remarkable for the feeble development of this muscle.

The *Supinator Longus* is absent. Up to the present I have looked upon the absence of this muscle as a myomorphine characteristic.

The *Extensor Carpi Radialis*, *Extensor Carpi Ulnaris*, and *Extensor Ossis Metacarpi Pollicis* † have the usual mammalian attachments.

The *Extensor Longus Digitorum* divides into four tendons, as in all Sciuromorpha; often, in the Myomorpha, the slip to the minimus is absent.

The *Extensor Minimi Digiti* divides for the annularis and minimus.

The *Extensor Indicis* only goes to the index.

The thumb is too rudimentary to require any short thumb-muscles.

The first row of palm-muscles consists of an *Adductor Indicis* and *Adductor Minimi Digiti*, which have the usual rodent disposition. Deep to these is a layer of double-headed Flexores breves, one for each of the four digits, and no muscles dorsad to these were found.

* P. Z. S. 1896, p. 188.

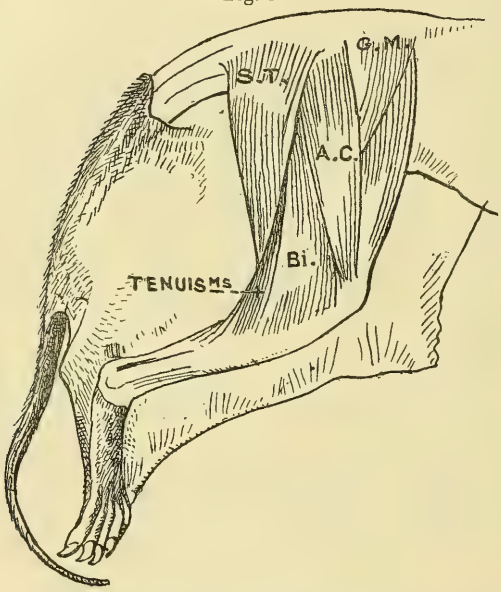
† The pollex is rudimentary.

Muscles of the Posterior Extremity.

Sartorius and *Tensor fasciæ femoris*.—These two muscles are feebly developed even for a rodent.

Ecto-gluteus and *Caudo-femoralis* (Agitator caudæ).—When I described the muscles of the Sciuromorphine and Hystricomorphine Rodents in 1894, I had not learned to draw any distinction between these two. The fact, however, was recorded that "in *Sciurus*, *Spermophilus*, and *Pteromys* the gluteus maximus (ecto-gluteus) is inserted by two slips, one into the third trochanter,

Fig. 3.



Muscles of Thigh (outer side).
S.T., Semitendinosus; G.M., Ectogluteus; A.C., Caudo-femoralis (Agitator caudæ); Bi., Flexor cruris lateralis (Biceps).

the other into the lower part of the femur." I have now no doubt that the upper of these is the true ecto-gluteus, the lower the caudo-femoralis or agitator caudæ. *Anomalurus* resembles these animals in the low insertion of the latter muscle; indeed the ecto-gluteus and caudo-femoralis together are inserted into the whole length of the femur (see fig. 4.)

The *Meso-gluteus*, *Ento-gluteus* and *Gluteus ventralis* (*Scansorius*) were present; the latter I have not hiterto seen in sciuro-

morphine rodents, but it is seldom such a distinct muscle as to be unmistakable.

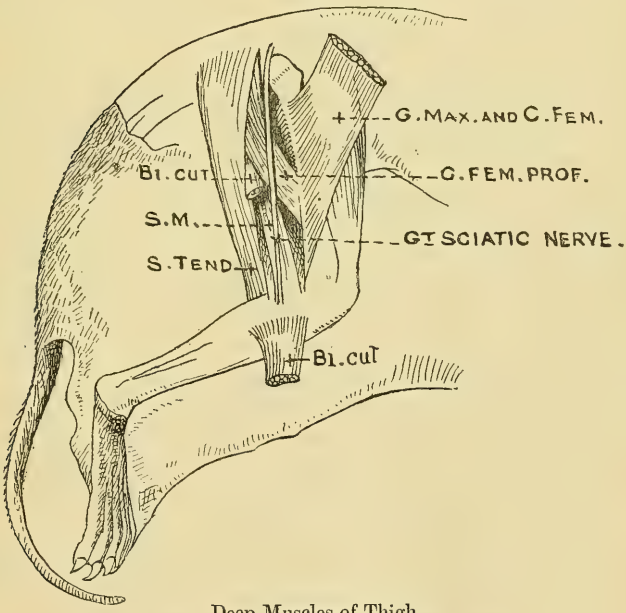
Nothing worthy of special remark was seen in the examination of the short rotator muscles of the hip.

The *Biceps femoris* (*Flexor cruris lateralis*) has only one head, and that from the tuberosity of the ischium (fig. 4). It is inserted into the fascia of the upper third of the leg. In most rodents a superficial head from the spines of the anterior caudal vertebræ is also present, but in *Sciurus* and *Pteromys* no head from this origin was found.

The *Tenuissimus* (Bicipiti accessorius) rises from the sacral vetebræ deep to the ecto-gluteus and runs down to be inserted with the posterior fibres of the biceps (fig. 3).

The *Semitendinosus*, as is usual in rodents, rises by two heads,

Fig. 4.



Deep Muscles of Thigh.
The references in this figure explain themselves.

one from the anterior caudal vertebræ, the other from the tuber ischii; these join in the upper third of the thigh, and are inserted into the junction of the upper and middle thirds of the internal surface of the tibia.

When the semitendinosus, caudo-femoralis, and ecto-gluteus are cut and reflected, the great sciatic nerve is exposed. Deep to this is a muscle which rises from the same origin as, but deep to, the semitendinosus, and after passing obliquely downward and forward, is inserted into the middle of the femur. Probably the name of caudo-femoralis profundus would best describe this (see fig. 4).

The *Semimembranosus* rises only from the tuber ischii, as is usual with rodents, and is inserted into the tibia deep to the internal lateral ligament of the knee.

The *Presemimembranosus* is quite distinct from the last and is closely connected with the adductor mass. This I have already pointed out (P. Z. S. 1894, p. 286) is a sciuromorphine characteristic.

The *Quadratus Femoris* is entirely fleshy, as in other Sciuromorpha.

The *Pectineus* is inserted just below the lesser trochanter of the femur.

The *Adductor longus* continues the plane of the last downward and is inserted just below it into about a third of the femur.

The rest of the *Adductor mass* rises from the ramus and tuber ischii, and is inserted into the lower two-thirds of the shaft of the femur.

The *Gracilis* (Adductor cruris) is a single broad muscle rising from the symphysis and ramus of the pubes and being inserted into the upper third of the shaft of the tibia. This single gracilis has been shown to be characteristic of the Sciuromorpha as opposed to the Myomorpha.

The *Tibialis anticus* rises from the tibia only, and is inserted into the innermost of the five metatarsal bones.

The *Extensor Longus Digitorum* has the usual femoral origin and is inserted into the outer four toes.

The *Extensor Proprius Hallucis* rises from the middle third of the fibula, and is inserted into the terminal phalanx of the hallux. The full complement of *Peroneal muscles* is present; viz., *Peroneus longus, brevis, quarti digiti* and *quinti digiti.*

The *Gastrocnemius* and *Soleus* have the usual rodent appearance, they form a twisted Tendo Achillis *.

* See Journal of Anat. & Phys. vol. xxviii. p. 414.

The *Plantaris* expands in the sole into a muscular *Flexor Brevis Digitorum.*

The *Flexor Tibialis* does not join the *Flexor Fibularis* in the sole. This is a sciuro- and myo-morphine characteristic.

The *Accessorius* is present, and is inserted into the plantar surface of the flexor fibularis. In the Myomorpha the accessorius is absent, but it is usually present in the Sciuromorpha.

The *Lumbricales* closely resemble those of the fore limb, but there are seven instead of six; one rises from each side of the tendons to the index, medius, and annularis toes, while the seventh comes from the fibular side of the tendon to the hallux.

The *Deep Muscles of the Sole* are arranged in two layers: the superficial consists of an oblique adductor hallucis and minimi digiti, while the deeper is formed by the double flexores breves to each toe. The abductor hallucis and minimi digiti are the enlarged and somewhat displaced marginal members of this series.

Having given a brief survey of the myology of *Anomalurus*, it remains to contrast these muscles with those of other rodents, and to see whether they throw any light on the position and relationship of this animal in the order. In the first place, it will be well to review the chief myological characteristics of the four suborders, and contrast them with those of *Anomalurus*.

From experience gained in former dissections, I believe that the following are the chief myological characteristics of the Sciuromorpha:—

1. The anterior deep part of the masseter lies in a groove in front of the zygomatic process of the maxilla.
2. The digastric muscles have a central tendon from which a fibrous arcade stretches across the middle line; to this the anterior bellies are attached and they are in contact in the mid-line of the chin.
3. The transverse mandibular muscle is usually present.
4. The omo-hyoid is present.
5. The omo-trachelian muscle (levator claviculæ) always rises from the atlas.
6. The subclavius is never continued over the supraspinatus as a sterno-scapularis muscle.
7. The coraco-brachialis brevis is always present, as are usually the medius and longus.

8. The supinator longus is generally present.
9. The pronator quadratus is never attached to more than the lower third of the forearm.
10. The presemimembranosus is closely connected with the adductor mass, instead of being separate or fused with the semimembranosus.
11. The gracilis is a single muscle.
12. The flexor tibialis does not join the flexor fibularis in the sole.
13. The accessorius pedis is present.
14. The rhomboideus capitis forms a continuous sheet with the other rhomboids.
15. The rectus ventralis (abdominis) does not decussate with its fellow at its origin from the symphysis pubis.

The foregoing are not all found in the Sciuromorpha alone, though all are points of distinction between the Sciuromorpha and one or more of the other three suborders. It is only by taking a large number of characters that one can hope to neutralize the effects of individual variation or to reduce its disturbing influence to a minimum.

It will be noticed that *Anomalurus* agrees with the Sciuromorpha in the following points:—Nos. 2, 3, 5, 6, 7, 9, 10, 11, 12, 13, 14, and 15, but differs from them in Nos. 1, 4, and 8.

In reviewing the myological characteristics of the Myomorpha it will be evident that in a great many points they resemble the Sciuromorpha.

The following are characteristics of the Myomorpha:—

1. A certain amount of the masseter always passes through the infraorbital foramen.
2. The digastric muscles have the sciuromorphine arrangement.
3. The transverse mandibular muscle is present.
4. The omo-hyoid is present.
5. The omo-trachelian always rises from the atlas.
6. The subclavius does not usually form a sterno-scapularis.
7. The coraco-brachialis brevis is seldom present, and the three parts of the muscle never occur together.
8. There are always two heads to the biceps cubiti.
9. The supinator longus is absent.

10. The presemimembranosus is quite distinct from the adductor mass.
11. The gracilis is usually double.
12. The flexor tibialis does not usually join the flexor fibularis in the sole.
13. The accessorius is absent.
14. The rhomboideus capitis is usually distinct from the rest of the rhomboid sheet.
15. The rectus ventralis often decussates with its fellow at its origin.

Anomalurus agrees with the Myomorpha in the following characters—Nos. 1, 2, 3, 5, 6, 8, 9, 12. But it must be borne in mind that Nos. 2, 3, 5, 6, 8, and 12 are points which are common to both Sciuromorpha and Myomorpha.

From a comparison of the foregoing, it will be seen that in the greater number of characteristic muscles *Anomalurus* agrees with both the Myomorpha and Sciuromorpha, but that, where these muscles vary in the two suborders, it agrees with the Sciuromorpha in six and with the Myomorpha in two.

The six points which mark its sciuromorphine affinities are :—

1. The presence of all three parts of the coraco-brachialis.
2. The close connection of the presemimembranosus with the adductor mass.
3. The single gracilis.
4. The presence of the accessorius pedis.
5. The rhomboids forming one sheet.
6. The non-decussation of the rectus ventralis.

Of these I regard Nos. 1, 2, 3, and 4 as of great importance.

The two points of myomorphine affinity are :—

1. The passage of a small part of the masseter through the infraorbital foramen.
2. The absence of the supinator longus.

The second of these is a negative point, and probably too much stress should not be laid upon it; but the first is a point of great importance and to my mind shows undoubted myomorphine tendencies.

With regard to the Hystricomorpha there is no need to go into so much detail because this suborder has some very sharply

marked characteristics, and without the presence of some of these no animal could be said to have hystricomorphine tendencies.

The chief of these characteristics are :—

1. A large part of the masseter passes through the infra-orbital canal.
2. The depressor mandibulæ (digastric) has no well-marked central tendon, and the anterior bellies are not in contact in the mid-line.
3. The subclavius is continued past the clavicle to the supra-spinosus fossa to form a sterno-scapularis muscle.
4. The flexor tibialis joins the flexor fibularis in the sole.

Anomalurus differs from the last three entirely, and from the first in degree, but this is a point in which the Myomorpha approach the Hystricomorpha.

It will have been noticed that, in the absence of the omo-hyoid *Anomalurus* differed from both the Sciuromorpha and Myomorpha, while in the Hystricomorpha it must be stated that the omo-hyoid may be present or absent. This may be looked upon as a feeble hystricomorphine tendency, but it is just as strong or as feeble a lagomorphine one.

It seems unnecessary to take up space by a detailed comparison of the muscles of the Lagomorpha with those of *Anomalurus*; firstly, because no one has suggested any relationship between the two, and, secondly, because I have never had the opportunity of completing my knowledge of the myology of this suborder by the dissection of a Pica. A general idea of the relationship of *Anomalurus* to the four suborders of rodents as illustrated by their muscles, may be gained by referring to the accompanying table, and, in criticising it, it should be borne in mind that the muscles have not been selected with any reference to *Anomalurus*. They were chosen as the result of previous dissections of many rodents, because they were found to vary with the different suborders. It cannot be too strongly insisted on that, if muscles are used for classificatory purposes, they should not be chosen haphazard, nor should one or two be used as crucial tests; but, by careful comparison of a large number of animals, some fifteen or twenty muscles should be picked out which vary more or less constantly with the different groups. The whole of these muscles should then be examined in the animal whose affinities are to be tested, and the average

	Sciuromorpha.	*Anomalurus.*	*Myomorpha.*	*Hystricomorpha.*	*Lagomorpha.*
1. Anterior deep part of Masseter.	In groove.	Through infraorbital foramen (small).	Through infraorbital foramen (small).	Through infraorbital foramen (large).	Absent.
2. Anterior bellies of Digastric.	In contact.	In contact.	In contact.	Separate.	Separate.
3. Transversus mandibulæ.	Usually present.	Present.	Present.	Absent.	Absent.
4. Omo-hyoid	Present.	Absent.	Present.	Present or absent.	Absent.
5. Omo-trachelian (Levator claviculæ).	Always from atlas.	From atlas.	Always from atlas.	Sometimes from basi-occipital.	From basioccipital.
6. Rhomboids	Continuous sheet.	Continuous sheet.	R. capitis separate.	Continuous sheet.	Continuous sheet.
7. Splenius colli	Absent.	Present.	Absent.	Sometimes present.	Present.
8. Recti ventrales (abdominis) origin from pubes.	Separate.	Separate.	Frequently decussate.	Sometimes decussate.	Separate.
9. Sterno-scapularis..... ...	Only subclavius.	Only subclavius.	Usually only subclavius.	Sterno-scapularis present.	Sterno-scapularis present.
10. Coraco-brachialis brevis.	Always present.	Present.	Rarely present.	Rarely present.	Present.
11. Biceps cubiti	Two heads.	Two heads.	Two heads.	One or two.	One head.
12. Supinator longus.....	Generally present.	Absent.	Absent.	Generally absent.	Absent.
13. Pronator quadratus ...	Lower $\frac{1}{4}$ of forearm or less.	Lower $\frac{1}{4}$.	Variable.	Often to $\frac{1}{2}$ forearm or more.	Absent.
14. Presemimembranosus ...	Fused with the Adductor mass.	Fused with the Adductor mass.	Separate.	Separate.	Separate.
15. Gracilis	Single.	Single.	Double.	Often double.	Single.
16. Flexor tibialis and Flexor fibularis.	Do not join in the sole.	Do not join in the sole.	Do not usually join in the sole.	Join in the sole.	Do not join in the sole.
17. Accessorius pedis.....	Present.	Present.	Absent.	Present.	Absent.

result will, in my experience, show a decided indication towards the group with which that animal is most nearly connected.

As a result of the application of this process to *Anomalurus*, I should say that its affinities are decidedly sciuromorphine in the main, though it shows certain definite myomorphine characteristics. It is extremely difficult to give an idea of the relationships of animals in a linear manner, and I submit a diagram giving my present ideas of the position of *Anomalurus*.

Fig. 5.

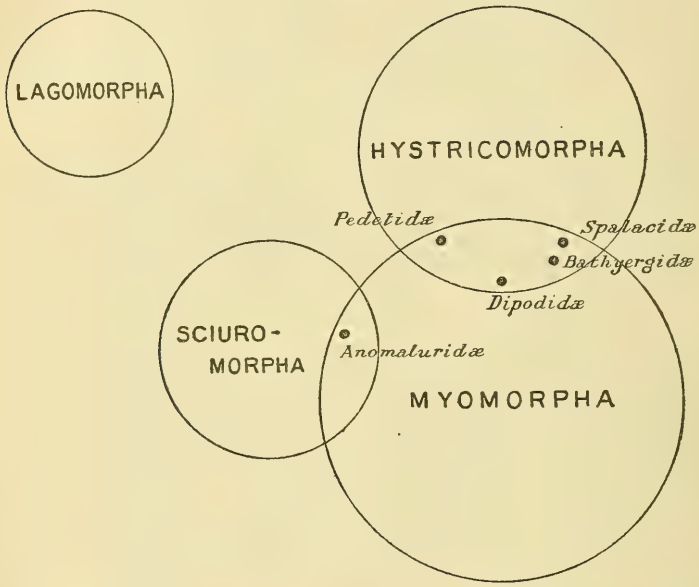


Diagram of the affinities of *Anomalurus*.

Winge * has urged that *Anomalurus* is closely connected with *Pedetes*. Fortunately I have lately had the opportunity of dissecting the latter animal, and have come to the conclusion † that it was rightly placed by Oldfield Thomas ‡ between the Hystricomorpha and Myomorpha. It may be advantageous to apply the same muscles used for determining the position of *Anomalurus* for a comparison of the two animals.

* "Jordfundne og nulevende Gnavere fra Lagoa Santa," E Mus. Lundii, iii. 1887.

† P. Z. S. 1898, p. 858.

‡ P. Z. S. 1896, p. 1012.

Comparison of Muscles of *Anomalurus* and *Pedetes*.

	Anomalurus.	*Pedetes*.
1. Anterior deep part of Masseter.	Through infraorbital foramen (small).	Through infraorbital foramen (large).
2. Anterior bellies of Digastric.	In contact.	In contact.
3. Transversus mandibulæ.	Present.	Absent.
4. Omo-hyoid	Absent.	Absent.
5. Omo-trachelian	From atlas.	From atlas.
6. Rhomboids	Continuous sheet.	Continuous sheet.
7. Splenius colli	Present.	Present.
8. Recti ventrales (abdominis) origin from pubes.	No decussation.	No decussation.
9. Sterno-scapularis	Subclavius only.	Subclavius only.
10. Coraco-brachialis brevis.	Present.	Absent.
11. Biceps cubiti	2 heads.	2 heads.
12. Supinator longus.....	Absent.	Absent.
13. Pronator quadratus ...	Lower $\frac{1}{4}$.	Lower $\frac{1}{3}$.
14. Presemimembranosus...	Fused with adductors.	Fused with semimembranosus.
15. Gracilis	Single.	Single.
16. Flexor tibialis and Flexor fibularis.	Do not join in the sole.	Do not join in the sole.
17. Accessorius pedis	Present.	Absent.

In these 17 points there are 12 in which the arrangement is the same in both animals, but it must be remembered that many of these simply denote myomorphine tendencies on the part of both; and in the five points in which they differ (Nos. 1, 3, 10, 14, and 17) the divergence is always towards the Hystricomorpha on the part of *Pedetes*, and the Sciuromorpha on the part of *Anomalurus*.

There are, however, three points (Nos. 4, 7, and perhaps 15) in which both animals wander away in the same direction from the arrangement which one might have predicted for them: it may be worth while considering these points in detail.

The first is the case of the omo-hyoid, which is absent in both animals, although it is constantly present in the Sciuromorpha and Myomorpha. In the Hystricomorpha it is present or absent, and its absence in *Pedetes* does not surprise us when the many hystricomorphine affinities of that animal are remembered. Its absence in *Anomalurus* is unexpected, and may be the result of an individual variation in the animal I dissected, or

it may be that I have framed the generalization that the omohyoid is constantly present in sciuromorphine and myomorphine rodents on the observation of insufficient material. To the presence of the splenius colli, I am not disposed to attach too great importance. When the splenius capitis is largely developed there is not room for all the fibres to be attached to the skull, and some of the posterior ones become inserted into the transverse processes of the anterior cervical vertebræ to form the splenius colli; still in the Sciuromorpha and Myomorpha this muscle is of rare occurrence.

The single gracilis is capable of another explanation than that of pointing to a relationship between *Pedetes* and *Anomalurus*. The muscle is not constantly double even in the Myomorpha, while in the Hystricomorpha it is more often single than double, and in the Sciuromorpha always single. We should, I think, expect that animals on the sciuromorphine or hystricomorphine borderland of the Myomorpha would be more likely to have a single than a double gracilis.

Similarities between *Anomalurus* and *Pedetes* in any one of the three muscles discussed would have been hardly worthy of notice, and it has been shown that no one of them is by itself of first-rate importance, but the three occurring together do perhaps furnish a somewhat feeble plea for a connection between the two animals. Possibly Winge's and Oldfield Thomas's views might be brought more into harmony by the use of a diagram such as I have suggested (fig. 5, p. 332), in which *Anomalurus* and *Pedetes* are not so very far asunder.

On some Australasian Collembola. By the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., LL.D., F.L.S.

[Read 1st June, 1899.]

The following paper contains descriptions of some new species of Collembola from New Zealand and Tasmania, kindly sent me by Mr. A. Dendy of Christchurch, N.Z. The collection also comprised some specimens, representing one or two other species, which however were not in a condition enabling me to describe them satisfactorily. They have been for some three